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### (54) Doors

(57) A door (100) comprises a framework of pultruded frame members (1), a core of structural density foam material (102), a pair of panels (103), and one or more hinges (104), the or each hinge (104) having a first plate portion (20) comprising a male member (22) extending therefrom wherein each frame member (1) has a cavity

(15) in which a weather seal (50) is receivable and a groove or slot (12) in which the male member (22) of the first plate portion (20) is received, the or each hinge (104) having a cavity (24) aligned with that of the frame member (1) in which a portion of the weather seal (50) is receivable.

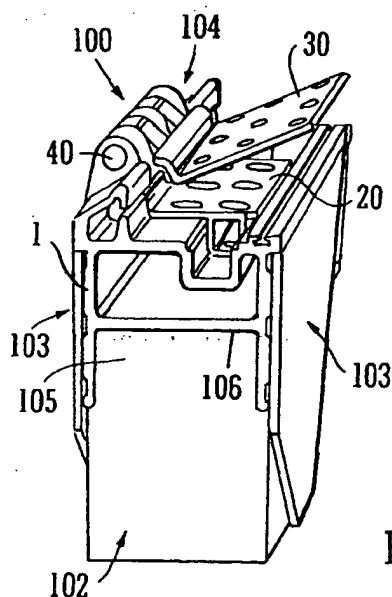


FIG. 4

EP 1 298 277 A2

## Description

[0001] This application relates to doors, components which can be used to fabricate doors and to components which can be used with so-fabricated doors.

[0002] Modern doors may be fabricated from solid wood although, because of environmental and industrial processing concerns such doors are becoming less common. Other doors may comprise a plastics framework of generally rectangular form as seen in elevation, front and rear surfaces faces of which being covered by panels. One such door is disclosed in GB-A-2279682.

[0003] A door is disclosed in GB-A-2183706 which comprises a framework of aluminium, extruded GRP or extruded PVCu section with metal reinforcements. The cavity, defined by the framework, is filled with a high density PVC foam (the specification is silent as to the actual density, although, at the date of that application, foam densities of around  $100 \text{ kg m}^{-3}$  were typically used) and the panels, which extend to each edge of the front and rear faces of the door, are formed from moulded GRP material.

[0004] In our co-pending British patent, application no. 0200498.4 (published as GB 2371075), we describe and claim a door which comprises a framework fabricated from pultruded sections formed of a thermoset resin with elongate fibres embedded therein. The cavity defined by the framework is filled with a structural density foam material, having a density of above  $250 \text{ kg m}^{-3}$ , i. e. of greater density than that previously utilised. The skins are preferably fabricated from a thermoset material so that the door has a low coefficient of thermal expansion and is suitably resistant to environmental conditions.

[0005] We have now discovered that some of the attendant disadvantages with prior art doors can be addressed by using thin-walled pultrusion techniques. One such disadvantage concerns the delamination of a panel from the framework, which can be caused by the ambient conditions as well as unintentional or intentional damage to the interface.

[0006] Other disadvantages arise from the provision of weather seals or draft excluders which are present to ensure that the door is suitable for use as an outside door. A further problem is the hanging of doors such that there is no gap in the weather seal created at the hinge.

[0007] A first aspect of the invention comprises a door having a framework of pultruded frame members, a core of structural density foam material, a pair of panels, and one or more hinges, the or each hinge having a plate portion comprising a male member extending therefrom, wherein each frame member has a cavity in which a weather seal is receivable and a groove or slot in which the male member of the plate is received, the or each hinge having a cavity aligned with that of the frame member in which a portion of the weather seal is receivable.

[0008] In a further aspect of the invention there is pro-

vided a pultruded elongate frame member for a door, the member comprising a pair of spaced apart arms extending from a hollow body portion, the body carrying two spaced apart extension portions each comprising a cavity in which first and second weather seals are receivable.

[0009] Preferably, each frame member has a stop against which an edge of the skin may abut or at least lie adjacent, the stop preferably being shaped and sized so that the whole edge of the skin abuts or lies adjacent the stop.

[0010] There is further provided, in a third aspect of the invention, a hinge for a door comprising first and second mutually pivotable plate members, the two being connected by a pin member extending through aligned apertures formed in or on a wall portion extending from each of the first and second plate members, the first plate member wall portion upstanding from the plate member and having located therein a longitudinal groove in which at least a portion of a weather seal is receivable, the groove being located below the apertures, the first plate member further comprising a leg portion depending therefrom which is shaped and sized to extend, in use, into a recess of the door to ensure accurate location of the hinge with respect to the door.

[0011] The wall portion of the second plate member preferably has a proximal edge portion upstanding therefrom, the cavities thereof preferably being located at a free end of that portion. The upstanding proximal edge portion may be shaped such that, in use with a weather seal received in the cavity of the first plate member, the proximal edge portion may abut the weather seal in a nominal closed position.

[0012] Preferably, the second plate member extends, at a distal edge thereof beyond a distal edge of said first plate member.

[0013] A distal edge portion of the second plate member may, in use, be abutable against a second weather seal, preferably receivable within a cavity of a frame member.

[0014] A further aspect of the invention provides a method of fabricating a door, the method comprising pultruding plastics material to form frame members having a hollow body portion from opposite sides of which a pair of spaced apart arms and an extension portion extend, the extension portion comprising a cavity, forming a core from structural density foam material, assembling the frame members about the core, joining the frame members together to form a framework, adhering panels to the framework and removing a part of the extension portion and locating therein a hinge member, the hinge member having a cavity aligned with that of the framework, and locating a weather seal in the aligned cavities.

[0015] In this application the term "structural density foam" refers to a foam with a density greater than  $250 \text{ kg m}^{-3}$ , although a preferred density of foam will be in the range of from 300 to  $400 \text{ kg m}^{-3}$ , and may be as high

as 800 kg m<sup>-3</sup>. Suitable materials are polyurethane and phenolic foams.

[0016] The preferred panel, core and frame materials for fabricating doors of the invention are thermoset plastics materials. Glass Reinforced Plastics (GRPs) preferably formed by Resin Transfer Moulding (RTM) or similar techniques and Sheet Moulding Compounds (SMC), preferably low pressure SMCs (LPSMCs) are preferred for the panels, whilst plastics materials such as polyesters, vinyl esters epoxy and phenolic resins are preferred for the frame members.

[0017] A further aspect of the invention provides method of hanging a door, the door having a framework of pultruded frame members, a core of structural density foam material with a density of at least 300 kg m<sup>-3</sup>, a pair of panels, and one or more hinges, the or each hinge having a first plate portion comprising a male member extending therefrom, wherein each frame member has a cavity in which a weather seal is receivable and a groove or slot in which the male member of the first plate portion is received, the or each hinge having a cavity aligned with that of the frame member in which a portion of the weather seal is receivable, the method comprising the steps of securing the first plate portion to the frame member with fixing means, said fixing means (e.g. screws) extending through apertures in the plate portion, through the frame member and into the core, and securing a second plate portion which is pivotally attached to the first plate portion, to a door frame.

[0018] In order that the invention may be more fully understood, it will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a transverse section through a profile of the invention;

Figure 2A is an end elevation of a hinge part of the invention;

Figure 2B is a plan view from below of the hinge part of Figure 2A;

Figure 2C is a side elevation along the line X-X' of Figure 2A;

Figure 3A is an end elevation of the other hinge part of the invention;

Figure 3B is a plan view from below of the hinge part of Figure 3A;

Figure 3C is a side elevation along the line Y-Y' of Figure 3A;

Figure 4 is a perspective view of a section through a door according to the invention; and

Figure 5 is a transverse section of the profile of Figure 1 to which a hinge of the invention is attached.

[0019] Referring to Figure 1, there is shown a profile 1 to form a frame for a door having a hollow, substantially rectangular, body portion 2 having an inner wall portion 3, opposed outer wall portion 4 and opposed side wall

portions 5, 6 joining the inner and outer wall portions 3, 4.

[0020] The side wall portions 5, 6 extend beyond the inner wall to form opposed side wall extensions 7, 8. Shallow recesses 9 are formed in the surfaces of the side wall portions 5, 6 and extensions 7, 8.

[0021] Abutment portions 10, 11 are present at the corners of the side wall portions 5, 6 and the outer wall 4.

[0022] The outer wall portion 4 has an anchoring groove 12. Two extension portions 13, 14, each having a respective cavity 15, 16 are present. The first extension portion 13 has a pair of opposed lips 17 to define an entrance to the cavity 15. The second extension portion 14 also has a pair of lips 18 which define an entrance to the cavity 16. The respective pairs of lips 17, 18 which define the entrances to the respective cavities 15, 16 are substantially orthogonal to one another.

[0023] The profile 1 is formed by pultruding a thermoset plastics material, such as polyesters, vinyl esters, epoxy and phenolic resins with fibres, such as glass, carbon or aramid, Terylene, Nylon or hemp embedded therein. Continuous elongate fibres are impregnated into the thermoset resin and are pulled through a pre-former into a heated die. The shape of the profile is determined by the shape of the die and the heat of the die causes the resin to polymerise. The profile 1 may be pultruded to any length and then cut to form appropriately sized frame members for a door.

[0024] Referring to Figures 2A to 2C, there is shown a first hinge plate 20 having a planar plate portion 21 from which depends a substantially rectangular foot portion 22, it is shown as being hollow although need not be. Upstanding from, and across the entire length of the plate portion 21 is a wall portion 23 which is provided with a longitudinal slot 24.

[0025] Integral with, and extending from, the wall portion 23 are three aligned bosses 25 each being provided with an aperture 26 aligned along a common axis.

[0026] A series of two through-holes 27 extend through the wall portion 23 between those parts contiguous with the aligned bosses 25, as indicated by the dotted lines in Figure 2C.

[0027] A further series of three through-holes 28 extend through the plate portion 21. A further series of through-holes 29 extend through plate portion 23 above the foot portion 22 and through the base of the rectangular foot portion 22.

[0028] Figures 3A to 3C show a second hinge plate 30 comprising a plate portion 31 from which upstands, along one longer edge thereof, a neck portion 32 on which are located two hollow bosses 33 having apertures 34 formed therethrough aligned along a common axis. The plate portion is provided with a series of nine through-holes 35.

[0029] The first and second hinge plates 20, 30 have their bosses aligned and a pivot pin is inserted through the aligned apertures 26, 34, as is shown in relation to Figure 4.

[0030] Both of the first and second hinge plates 20, 30 may be formed from stainless steel although other materials such as zinc-aluminium alloys may be die cast to form the plates 20, 30. Also, aluminium or bronze may be extruded to form lengths of the plates which can be cut to size.

[0031] Referring now to Figure 4, there is shown a part of a door 100 having a frame formed from a plurality of profiles 1 (only part of a single profile 1 being shown), a structural density polyurethane foam core 102 and a pair of skins or panels 103. A hinge 104 formed with first and second hinge plates 20, 30 and a hinge pin 40 is also provided.

[0032] To form the door 100, a structural density foam core material 102, of say 300 kg m<sup>-3</sup>, is formed by either shaping a block or moulding an appropriate material, so that it has an edge portion 105 which can fit within the side wall extensions 7, 8 of a profile 1 with the edge 106 of the core 102 abutting the inner wall portion 3 of the profile 1.

[0033] Profiles 1 are formed by pultrusion, as previously explained, and are then cut to size. The lengths of profiles 1 are placed about the foam core 102 such that the side walls 7, 8 embrace the edge portion 105 of the foam core 102 and the edge 106 abuts inner wall portion 3 of the profile 1. A suitable adhesive may be used to secure the foam core 102 in place with respect to the profile 1. Typically, the four lengths of profile 1 are then glued and/or heat treated at their interfaces to form a continuous rectangular framework.

[0034] An adhesive composition, usually comprising curable resin and an activator to polymerise (e.g. cross-link) the resin, is mixed and then applied to the outer surface of the wall portions 5, 6 and side wall extension 7, 8. The adhesive will fill the shallow recesses 9 thereby helping to key the adhesive. A suitable adhesive is a cross-linked acrylate.

[0035] Skins 103 are then applied to the outer faces of the framework. The skins may be compression moulded onto the framework/core substrate or they may be preformed and glued. Preferred skin materials are those fabricated from thermoset materials such as GRP or sheet moulding compound (SMC). Preferred SMC compounds are those considered to be low pressure SMCs, such as Crystic Impreg obtainable from Scott Bader Limited of Northampton, United Kingdom.

[0036] With thermoset plastics materials forming the skins 103, core 102 and frame member 1 the entire door 100 will have a low coefficient of thermal expansion and will be suitable for outdoor or indoor use. Further, because each of the materials has a similar, low coefficient of thermal expansion, components of the door will not expand relative to one another, thereby reducing the tendency for damage to occur to the components by, say, delamination.

[0037] To attach a hinge 104, a length of extension portion 13 of profile 1 is removed, typically by abrasion and/or sawing or cutting of the profile 1. The first hinge

plate 20 is then located in the space formed by removing the part of the extension 13. The foot portion 22 of the hinge plate 20 is located in the anchoring recess 12 of the profile 1, an edge of the hinge plate 20 abutting or at least being adjacent stops 19 of the profile 1. When the plate 20 is so-located, the cavity 15 will have a portion thereof aligned with the slot 24 of the plate member 20.

[0038] Screws are then screwed through holes 27, 28, 29, through the profile 1 and into the foam core 102 to lock the hinge plate 20 into position.

[0039] The second hinge plate 30 is connected to the first hinge plate 20 by reception of a pivot pin 40 extending through aligned apertures 26, 34 formed in respective aligned members 25, 33 to form a hinge 104. Screws are used to mount the door 100 to a door-frame (not shown) via screws holes 35.

[0040] Referring now to Figure 5, wherein similar components are identified by the use of a prime (') and identical components bear the same identifying numeral, there is shown a section through a profile 1 to which a hinge 104' is attached.

[0041] The hinge 104' comprises first and second hinge parts 20', 30'. The first part 20' has a foot portion 22' which is located in the anchoring groove 12 of the profile 1. The second part 30' has a plate portion 31' having a proximal upstanding neck portion 32'. Terminal portions of the neck portion 32' have been bent to form bosses 33' which define apertures 34' aligned upon a common axis.

[0042] Either before or after the door 100 is mounted to the door-frame a, typically rubber, neoprene or the like, weather seal 50 is inserted into the cavity 15 of profile 1. The weather seal 50 has a retaining portion 51 and a sealing portion 52, which may be hollow lips 17, engage a waist portion 53 located between the retaining and sealing portions 51, 52. As slots 24, 24' are aligned with cavity 15 the weather seal 50 can be forced into slots 24, 24' thereby providing a continuous weather seal strip. It will be noted that slot 24, 24' are of a smaller size than cavity 15. However, the retaining portion 51 is sized so that it can be accommodated within the slots 24, 24'. The sealing portion 52 of the weather seal 50 which extends from the slots 24, 24' is accommodated within the neck portion 32, 32' of second hinge plate 30, 30'.

[0043] A further weather seal or draft excluder 60 may be located within cavity 16 of the frame member 1. It will be noted that second hinge plate 30, 30' extends over the cavity 16, therefore, the door-frame, to which the plate 30 is attached, also extends over the cavity 16. Thus, when the door 100 is shut, the weather seal 60 located within cavity 16 will abut the door-frame, preventing or reducing drafts and/or the ingress of precipitation. The weather seal 60 may be formed from plastics or rubber materials. It may comprise a brush portion extending from a base portion.

[0044] The lips 17, 18 prevent the weather seals 50,

60 from being removed from their respective cavities 15, 24, 24', 16.

[0045] The major surfaces of the core 102 are dimensioned so as to be flush with the outer surface of side walls 7, 8. When the skin 103 is attached to the frame/core substrate there is no 'step' (i.e. displacement) between the surface of the core 102 and the outer surface of the side walls 7, 8 which affords good adhesion of the skins 103 to the frame. Because larger amounts of adhesive are retained within the recesses 9 with a smaller amount smeared over the surface of the side walls 7, 8 and side portions 5, 6 excellent adhesion is experienced by the skins 103 to the frame/core substrate.

[0046] A flexible sealant and, in some cases, adhesive is applied to abutment portions 10, 11. The edges of the skin 103 are at least flexibly adhered to those portions 10, 11. The sealant prevents the ingress of precipitation. A preferred sealant is based upon silicone. Because the edge of the skin 103 is not exposed, there is little or no risk of delamination of the skin 103 from the frame/core substrate.

[0047] Further, it will be appreciated that the edges of the skins 103 are not exposed as they abut or at least lie adjacent the stops or abutment portions 10, 11. The outer surfaces of the skins 103 are flush with the walls of the extension portions 13, 14 which improves appearance and reduces the likelihood of intentional damage being caused to the door 100.

[0048] The recess 12 of frame member 1, located on an opposite or orthogonal face to hinge 104 may have a lock or other device located therein.

[0049] The skin 103 may be formed in a variety of colours and with a variety of surface patterns so as to provide, for example, a wood-grain effect.

[0050] The core 102 may be formed with a missing portion into which a letter-box, glazing panel or the like may be fitted once the door 100 has been made. Alternatively, the completed door 100 may have portions cut therefrom so that such 'door furniture' may be fitted. If the core 102 is formed with parts missing for the reception of door furniture, the skin 103 may be moulded thereto to cover the exposed core parts. Indeed, it is the use of structural density foam materials which enables such fittings to be located within the door 100 without the need for further reinforcements, which are needed in prior art doors.

[0051] It will be appreciated, that the use of structural density foam also allows the door 100 to be supported by hinges 104 without the provision of further reinforcement for the screws. Typically two, three or four hinges 104, 104' will be used to support a door 100 of the invention.

#### Claims

1. A door (100) having a framework of pultruded frame members (1), a core of structural density foam ma-

terial (102), a pair of panels (103), and one or more hinges (104), the or each hinge (104) having a first plate portion (20) comprising a male member (22) extending therefrom, wherein each frame member (1) has a cavity (15) in which a weather seal (50) is receivable and a groove or slot (12) in which the male member (22) of the first plate portion (20) is received, the or each hinge (104) having a cavity (24) aligned with that of the frame member (1) in which a portion of the weather seal (50) is receivable.

2. A door (100) according to Claim 1, wherein the frame member (1) comprises a body (2) from which protrudes a first extension portion (13) in which the cavity (15) is located.

3. A door (100) according to Claim 2, wherein a portion of the hinge (104) is seated on part of body (2) from which the extension portion (13) has been removed, the respective cavities (15; 24) being aligned on a common axis.

4. A door (100) according to any preceding Claim, wherein the frame member (1) comprises a second extension portion (14) having a cavity (16) in which a second weather seal (60) is receivable.

5. A door (100) according to Claim 4, wherein the hinge (104) comprises a second plate portion (30) which, in use in a nominal closed position, has a distal edge which extends beyond a distal edge of the first plate portion (20).

6. A door (100) according to Claim 5, wherein the distal edge of the second plate portion (30) extends beyond the second cavity (16).

7. A door (100) according to any preceding Claim, wherein each frame member (1) has a pair of arms (7, 8) which embrace a distal edge portion (105) of the core (106).

8. A door (100) according to Claim 7, wherein said arms (7, 8) carry longitudinal recesses (9).

9. A door (100) according to Claim 7 or 8, wherein the panels are adhered to the arms (7, 8) of the frame members (1).

10. A door (100) according to any preceding Claim, wherein each frame member (1) comprises abutment portions (10, 11) which distal edges of the panels (103) abut or at least lie adjacent thereto.

11. A door (100) according to any preceding Claim, wherein outer faces of the panels (103) are flush with the portion of the frame member (1) to which

- the edges of the panels (103) are adjacent.
12. A door (100) according to any preceding Claim, wherein the density of the core is above  $300 \text{ kg m}^{-3}$ .
13. A pultruded elongate frame member (1) for a door, the member (1) comprising a pair of spaced apart arms (7, 8) extending from a hollow body portion (2), the body portion (2) carrying two spaced apart extension portions (13, 14) each comprising a cavity (15, 16) in which first and second weather seals are receivable.
14. A member (1) according to Claim 13, wherein pairs of lips (17, 18) define the entrances to the cavities (15, 16).
15. A member (1) according to Claim 13 or 14, wherein the openings to the cavities (15, 16) lie at right angles to one another.
16. A member (1) according to Claim 13, 14 or 15, wherein the body portion (2) comprises a groove or slot (12) to receive, in use, a part of a hinge.
17. A member (1) according to any of Claims 13 to 16, wherein arms (7, 8) extend from the body portion (2).
18. A hinge (104; 104') for a door comprising first (20; 20') and second (30; 30') mutually pivotable plate members, the two being connected by a pin member (104) extending through aligned apertures (26, 34; 26', 34') formed in or on a wall portion (23, 32; 23', 32') extending from each of the first and second plate members, the first plate member wall portion (23; 23') upstanding from the plate member (20; 20') and having located therein a longitudinal groove (24; 24') in which at least a portion of a weather seal is receivable, the groove (24; 24') being located below the apertures (26; 26'), the first plate member (20; 20') further comprising a leg portion (22; 22') depending therefrom which is shaped and sized to extend, in use, into a recess of the door to ensure accurate location of the hinge (104; 104') with respect to the door.
19. A hinge (104; 104') according to Claim 18, wherein the wall portion (32; 32') of the second plate member (30; 30') has a proximal edge portion (32; 32') upstanding therefrom, said aligned cavities (34; 34') being located at a free end of that portion (32; 32').
20. A hinge (104; 104') according to Claim 19, wherein the upstanding proximal edge portion (32; 32') is shaped such that, in use with a weather seal received in the cavity (24; 24') of the first plate member (20; 20'), the proximal edge portion (32; 32') abuts the weather seal in a nominal closed position of the hinge (104; 104').
21. A hinge (104; 104') according to Claim 18, 19 or 20, wherein a distal edge of the second plate member (30; 30') extends beyond a distal edge of said first plate member (20; 20').
22. A method of fabricating a door having a hinge member and a weather seal, the method comprising the following steps:
- pultruding plastics material to form frame members having a hollow body portion from opposite sides of which a pair of spaced apart arms and an extension portion extend, the extension portion comprising a cavity;
  - forming a core from structural density foam material;
  - assembling the frame members about the core;
  - joining the frame members together to form a framework;
  - adhering panels to the framework;
  - removing a part of the extension portion and locating therein a hinge member, the hinge member having a cavity aligned with that of the framework; and
  - locating a weather seal in the aligned cavities.
23. A method of hanging a door, the door having a framework of pultruded frame members (1), a core of structural density foam material (102) with a density of at least  $300 \text{ kg m}^{-3}$ , a pair of panels (103), and one or more hinges (104), the or each hinge (104) having a first plate portion (20) comprising a male member (22) extending therefrom, wherein each frame member (1) has a cavity (15) in which a weather seal (50) is receivable and a groove or slot (12) in which the male member (22) of the first plate portion (20) is received, the or each hinge (104) having a cavity (24) aligned with that of the frame member (1) in which a portion of the weather seal (50) is receivable, the method comprising the steps of securing the first plate portion to the frame member with fixing means, said fixing means (e.g. screws) extending through apertures in the plate portion, through the frame member and into the core, and securing a second plate portion which is pivotally attached to the first plate portion, to a door frame.

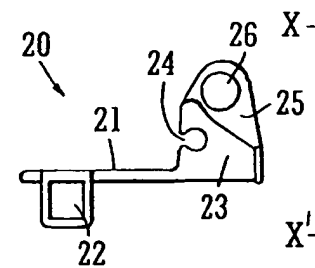
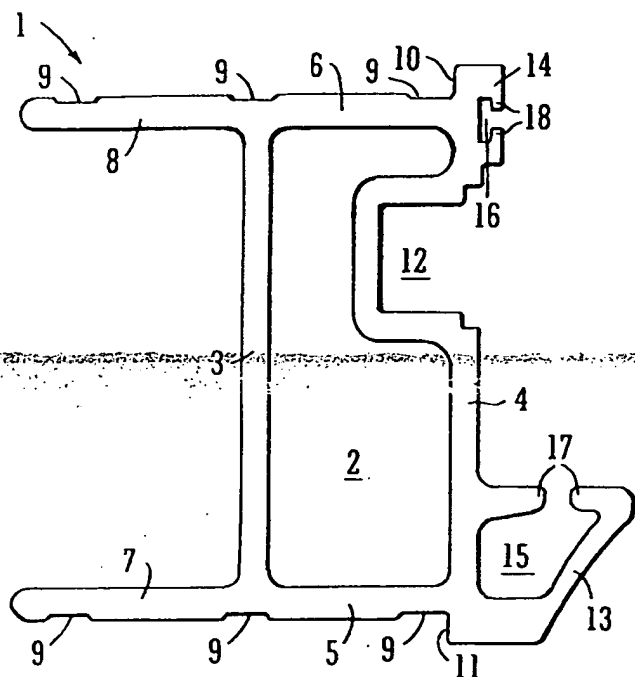


FIG. 2A

FIG. 1

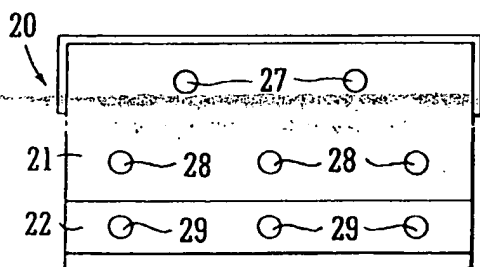


FIG. 2B

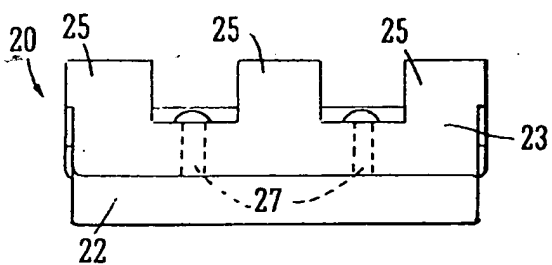


FIG. 2C

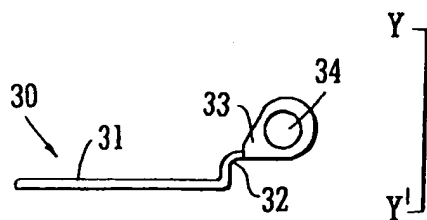


FIG. 3A

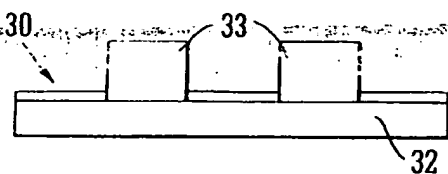


FIG. 3C

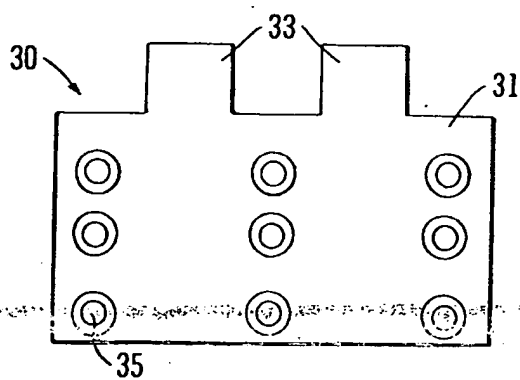


FIG. 3B

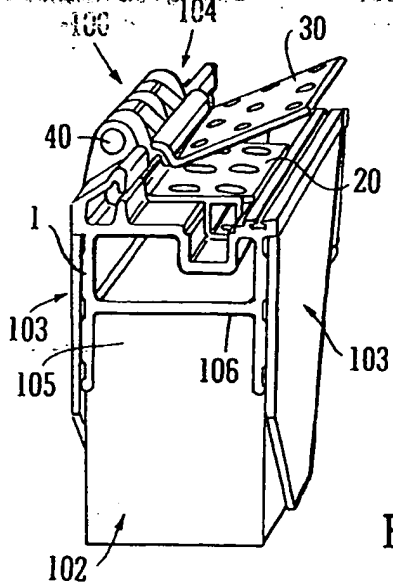


FIG. 4



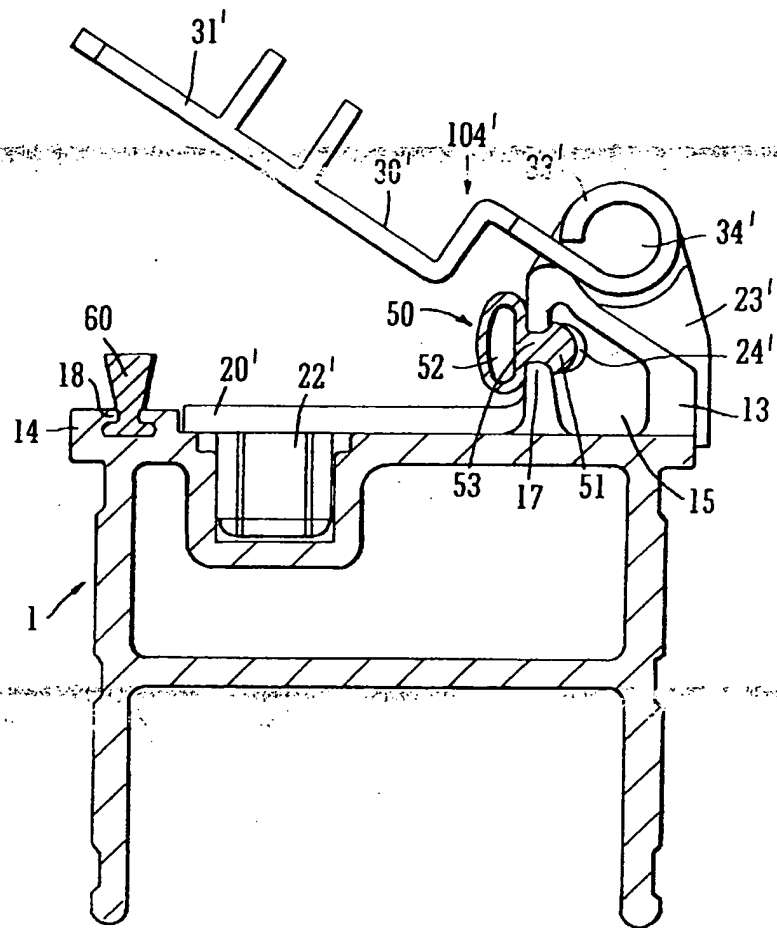


FIG. 5

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